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Via FedEx

October 2, 2012
In reply refer to SHEA 112479

Mr. Mark Malinowski, P.G.
DTSC Performance Manager – SSFL
Department of Toxic Substances Control
8800 Cal Center Drive
Sacramento, CA 95826-3200

Subject: Final In-situ Chemical Oxidation Work Plan Addendum for Santa Susana Field Laboratory, Ventura County, California

Dear Mr. Malinowski:

The Boeing Company has reviewed the comments that the Department of Toxic Substances Control (DTSC) provided on the In-situ Chemical Oxidation Work Plan Addendum *(MWH – January, 2012)*, in an email from Roger Paulson dated April 24, 2012. The Boeing Company has revised the work plan based on those comments in the attached final document.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Regards,

Paul J Gallacher

Thomas Gallacher
Director, Santa Susana Field Laboratory
Environment, Health and Safety

MOB:jag
Enclosure: Workplan Addendum #1 for In situ Chemical Oxidation Field Experiment

cc: Roger Paulson, DTSC (via E-mail)
Richard Andrachek, MWH (via E-mail)
Kevin Murdock, CH2M HILL (via E-mail)

3 LABORATORY METHODS

The University of Waterloo will conduct the majority of the analyses, with the exception that five percent of the samples will be sent to a California-certified off-site laboratory for analysis by EPA Method 8260B.

3.1 SAMPLE ANALYSES METHODS

3.1.1 VOC Sample Extraction

Methanol extraction is expected to remove the sorbed as well as the dissolved phase contaminants from the matrix and prevent loss of these volatile constituents from the sample container during the extraction time period required.

Each sample will be shaken to facilitate the extraction of pore water into the methanol. Samples will be allowed to extract in a cooler/refrigerator at 4°C for a minimum of six weeks prior to performing the VOC analyses. These time periods have been selected based on previous studies. This shake-flask technique may be combined with sonication- or microwave-assisted solvent extraction where sound waves or microwaves are used to maximize the transfer of the matrix pore water and organic constituents into the extractant. To check the completeness of the extraction, ten percent of the VOC samples will be analyzed two weeks following the initial analyses for comparison of the amount of mass measured in the same samples (replicate analyses with a time lag).

3.1.2 Pore Water VOC Concentrations

Previously, rock samples that were preserved in HPLC grade methanol were sent to a contract laboratory and analyzed using EPA Method 8021B (EPA, 1996). This provided a detection limit of 50 micrograms (μg) of TCE per liter of methanol. This protocol has been modified to provide improved detection limits using equipment and methods developed at the University of Waterloo for quantification of selected VOC compounds, specifically, those listed in Table 1. However, five percent of the total number of samples that are analyzed at the University of Waterloo will also be sent to a commercial laboratory for laboratory cross-check purposes using EPA Method 8260. The

commercial lab will screen for the complete list of VOC analytes, including CFC-113 and 1,4-dioxane, despite higher detection limits.

Rock subsamples collected in the 40 mL glass sample bottles will be sent to the University of Waterloo for analysis. After the VOC's have been completely extracted into the methanol (a period of at least two weeks), an aliquot of methanol will be injected directly into a gas chromatograph (GC) for separation and quantification using a micro-electron capture detector (μ–ECD). The list of analytes to be quantified is provided in Table 1.

The direct, on-column injection of methanol onto the gas chromatograph has been currently tailored for analysis of TCE and relevant breakdown products so that the resulting detection limit and run times are significantly lower than that reported by the previous contract laboratory. These improved detection limits in methanol have been converted to equivalent pore water concentrations for those compounds studied in our method development. The GC specifications for the new methanol direct on-column injection technique are summarized below:

- GC: HP 6890 with autosampler
- Column: HP-1 30m, 0.32mm ID, 4μm stationary phase
- Injection: 1μL liquid, cold on-column
- Carrier gas: Helium
- Detector: μ–ECD
- Analysis turnaround time: 17 minutes

Table 1. Method Detection Limits (MDL)

Analyte	Method MDL (µg/L): On-column injection (1µL MeOH)	MDL Equiv. GW Conc. (µg/L)*
1,1 DCE	7	0.41
t-DCE	5.5	0.43
c-DCE	3.5	0.34
TCE	0.1	0.27
PCE	0.1	0.12
Chloroform	0.3	6
1,1,1-TCA	0.5	2
CFC-113	0.3	1.1

***Note:** $\rho_{b\ wet}$=2.45 g/cm^3 ; ϕ_m=12.86%; $R_{1\text{-}1\text{-}DCE}$=2.2; $R_{t\text{-}DCE}$=2.1; $R_{c\text{-}DCE}$=2.6; R_{TCE}=3.3; R_{PCE}=7.6 and assuming 40 cm^3 of rock in 60 mL of MeOH.

3.1.3 Moisture Content/Porosity Measurements

The preserved samples will be placed in a cold storage room (4°C) until ready for gravimetric determinations. The samples will be unwrapped, placed on a pre-weighed aluminum weighing tray, and weighed. The sampled will then be oven-dried at 105°C for four days, allowed to cool to room temperature in a desiccator, and a final weight determined. The volume of the sample will be determined by submerging the oven-dried sample in a container of mercury and measuring its displacement. This allows calculation of sample porosity, moisture content, and wet and dry bulk densities. These data, along with the VOC analyses, will be used for calculating matrix pore water concentrations.

3.1.4 Laboratory Permeability Measurements

Samples collected for permeability measurements will be measured at the University of Waterloo. The preserved rock core samples obtained from the field will be sub-cored to one-inch diameter and variable lengths ranging from one to six centimetres. The samples will then be oven-dried at 105°C for greater than 24 hours before being placed in a flexible-walled permeameter cell. A confining pressure of 100 psi will be applied to the sample cell using nitrogen gas. Sample hydraulic conductivities will be determined from measuring the permeability of the dried samples to air.

3.1.5 Diffusion Coefficient Measurements

Laboratory methods will be developed to quantify the amount of sorption to rock matrix solids using batch and/or diffusion transport experiments using TCE as the solute of interest.

3.2 LABORATORY QA/QC

A minimum of five percent of all methanol preserved subsamples will have aliquots of the methanol extract removed after the samples have been allowed to fully extract. These aliquots will be sent to a contract laboratory for independent confirmation of analyte concentrations. Spiked methanol aliquots of known concentration will also be sent to the commercial laboratory to test compare the different analytical techniques. A minimum of five percent of all samples collected in the field will be split duplicates and will be analyzed by the University of Waterloo.

3.3 DETERMINING DRY WEIGHT OF ROCK SAMPLES FOR POROSITY ESTIMATION

Each sample will be emptied into a pre-weighed filter cone after the rock sample has been analyzed for VOCs. The sample jar will be rinsed with methanol to ensure that all the fines have been flushed onto the filer paper, and the filter cone with the sample will then be allowed to dry under a fume hood. Once dry, the filter paper and sample will be replaced back into the original sample jar and baked at 40°C until dry. The sample will then be cooled to room temperature in a desiccator and weighed in order to obtain the dry bulk density and moisture content of each sample, from which the saturated porosity can be estimated. During this process, each sample will be described again, and notes will be kept in the field notebook. These data, along with the VOC analyses, will be used for calculating matrix pore water concentrations, in order to minimize errors introduced by assuming a uniform porosity and density for all samples.

4 REFERENCES

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Groundwater Resources Consultants, Inc. 1992. Results of collection and analyses of rock cores, Santa Susana Field Laboratory. A consulting report prepared for Rockwell International Corporation, Rocketdyne Division, Canoga Park, California. Report 8640M-168, May 4, 1992.

Montgomery Watson. 2000. Technical Memorandum, Conceptual Site Model Movement of TCE in the Chatsworth Formation. April.

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U.S. Environmental Protection Agency (EPA). 1996. Test methods for evaluation solid waste, physical/chemical methods. *SW-846, Final Update III*, Revision 2. Method 8021B, Aromatic and halogenated volatiles by gas chromatography using photoionization and/or electrolytic conductivity detectors.

Appendix G

Responses to DTSC Comments on Work Plan Addendum

MWH